

WHAT IS THE HYDROLOGIC CYCLE?

The hydrologic cycle is a process in which water goes from the Earth, to the air, then back to Earth. In this process, water turns from solid to liquid to gas over and over again.

IMPORTANT VOCABULARY

Hydrologic - dealing with water

Water Vapor - water in its gas form; found in the air

Evaporation - when liquid water turns to gas

Condensation - when water vapor becomes a liquid

Precipitation - when water vapor comes back to the earth as rain, snow, hail, or sleet

Surface Runoff - water that runs along the ground, flowing into lakes, rivers and ponds

Groundwater - water located in springs or wells underground

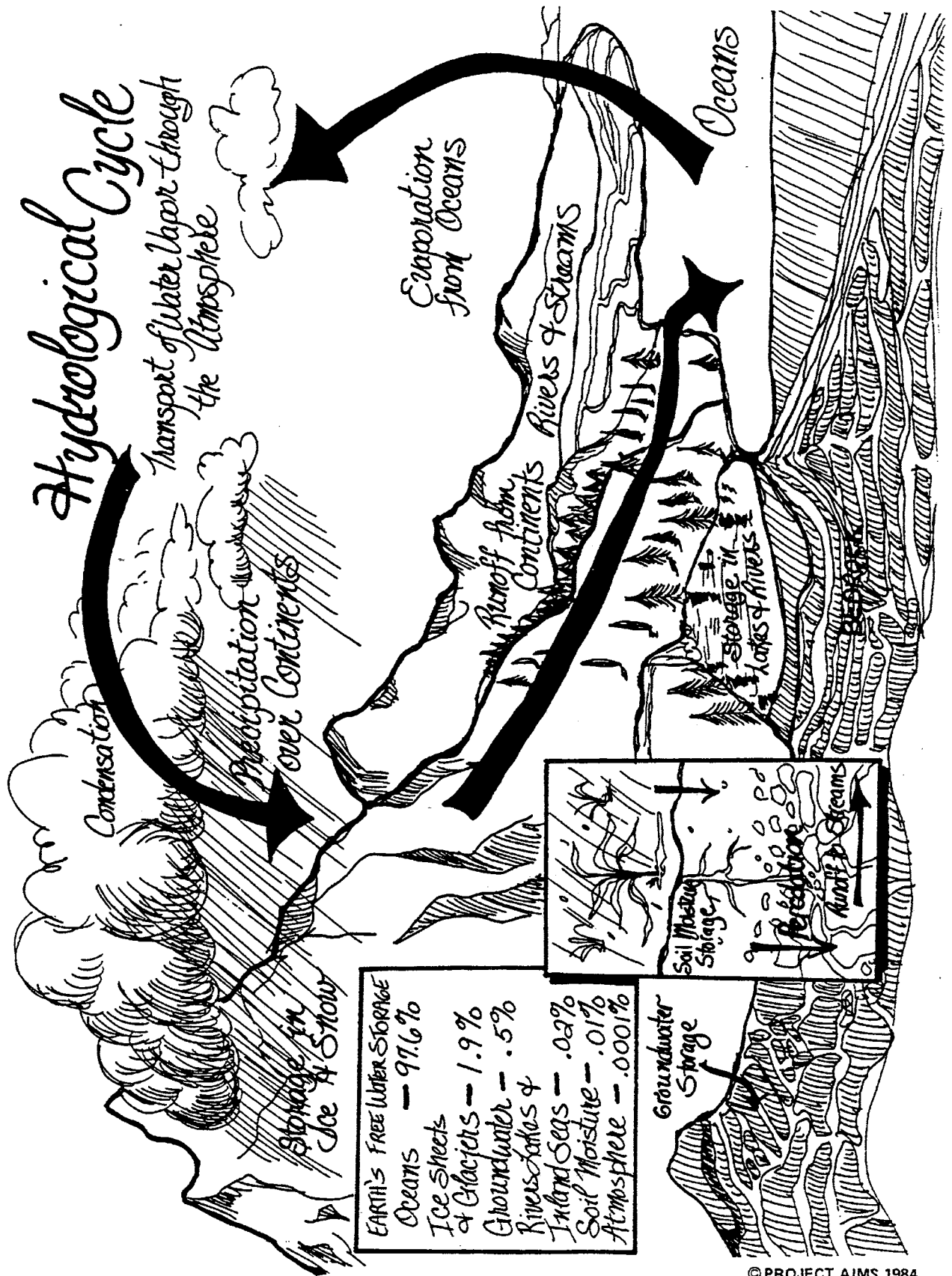
Aquifer - large water source that is located under ground

Percolation - when water moves downward, underground, through openings in the soil

In this cycle, water **evaporates**. It then becomes invisible and travels upward into the air to join with the clouds. It comes back down to Earth as **precipitation** occurs. This repeats. The **hydrologic** cycle never stops. What would happen if this cycle *did* stop?

After **precipitation** occurs, the runoff travels along the ground to fill ponds, lakes, and rivers. What does not become surface runoff, travels downward through the openings in the soil to fill large underground water sources known as **aquifers**. This process is known as **percolation**.

Different places receive different amounts of **precipitation**. Areas that are close to large bodies of water are more likely to have a higher amount of **precipitation**. Why do think that might be?



WATER SOURCES

There is no such thing as new water. The water that is available for usage now is the same water that the Indians used and the same water the dinosaurs used before them. This 1% is also all polluted water.

Citizens in Michigan are truly fortunate for we have 1/5 of the world's fresh water right outside our back doors. Unfortunately, this causes us to be among the worst offenders in polluting and wasting water.

Our water can be supplied by individual wells, which tap into the underground water table or by municipalities, which get their water from lakes, rivers, or aquifers. Municipalities examine it for purity, treat it, and then distribute it to individuals as well as businesses.

Most municipalities obtain their water from underground sources. 80% of all cities use underground sources because the amount of underground water is 30x greater than all the lakes and streams combined. Approximately 88 billion gallons per day are removed from underground sources.

Locate your city in the Michigan map and tell what type of source it used for water.

Find out what sources are used for other cities in Michigan. Place them on the map along with their sources.



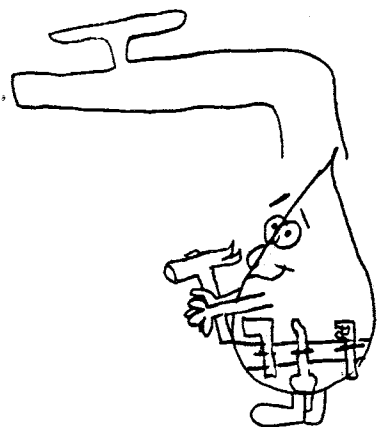
Polluted Water

WATER SOURCES?



WATER TREATMENT

All municipalities that supply water to its residents are responsible for insuring that the water meets federal and state regulations. They measure these pollutants in parts per million, parts per billion, and parts per trillion.

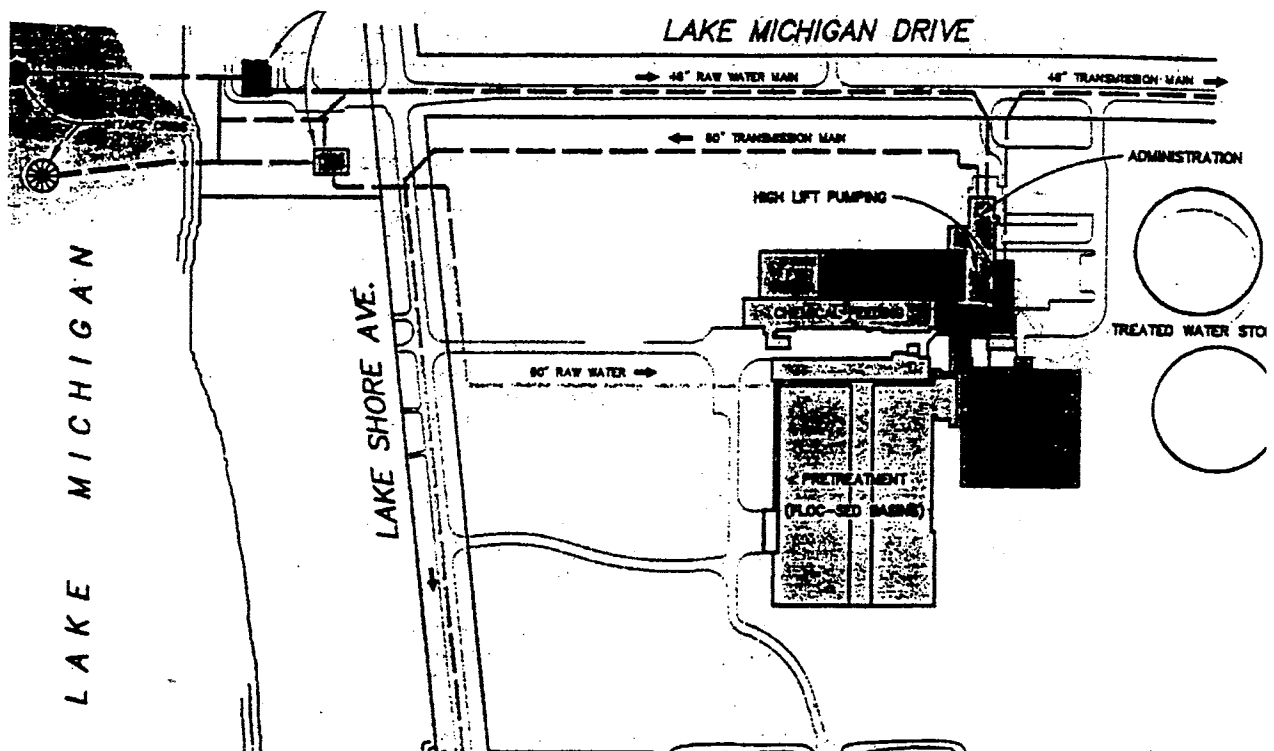


1 ppm = 1 drop in 10 gallons of water
1 ppb = 3 drops in Mr. VanderMoere's pool
1 ppt = 1 drop in a rectangle
width - length of middle school
length - from back of the school to the far
side of the football field
height - ground level to the roof of the school

Steps in Water Treatment

- A. INTAKE - Water enters the system (see Water Intake Crib)
- B. ADDITION OF CHEMICALS - Alum (aluminum sulfate) and polymers are added to the water. Chlorine may also be added in this step, however, Grand Rapids adds this at the intake.
- C. COAGULATION AND FLOCCULATION - Alum and other particles from step B cling to particles in the water (coagulation). As the particles become large they are called floc.
- D. SEDIMENTATION - The water with floc flows into large basins where the floc settles to the bottom and is removed.
- E. FILTRATION - The water on top of step D is pumped into large tanks filled with layers of various sizes of sand and gravel where it filters through to the bottom. Periodically the filters are back washed to remove excessive amounts of particles. This water is sent back through to step C.
- F. DISINFECTION - A small amount of chlorine and other disinfectants are added to kill any remaining germs. If a municipality uses groundwater, this may be the only step needed to treat their water.
- G. STORAGE - The treated water is stored to allow time for the chlorine to work.

LAKE MICHIGAN WATER INTAKE AND FILTRATION PLANT



WATER SYSTEM EXPANSION

After more than ten years of study, design and construction, the City of Grand Rapids has completed a major expansion of its water supply system. The new system has increased the Lake Michigan Filtration Plant capacity to 75 MGD to a total of 135 MGD. This enabled the city to decommission the 40 MGD Monroe Filtration Plant which treated Grand River water. The project cost was \$136,000,000 representing the single largest public works project in the City's history.

The improved water supply system provides the following benefits for the customers:

- All of the water supply is taken from Lake Michigan, the highest quality water available.
- Substantial energy savings are being realized by utilizing the new 60" transmission main.
- System reliability is provided through duplicate facilities for the intake, treatment plant and transmission mains.

The City of Grand Rapids is proud of the new improved water supply system which will enable the City to supply its citizens and customer communities with high quality, treated Lake Michigan water.



WATER USE

In the United States, each American uses about 185 gallons of water *per day*. That is a lot of water. How much would the average American use in a 30 day month?

a.) _____ x _____ = _____

The average cost for water use is about \$1.30 per 1,000 gallons. What would an average American pay for one month's water use?

b.) \$1.30/1000 gallons x (answer to "a") = _____

How much would it cost for your family's water use in a 30 day month?

c.) _____ x _____ = _____

One two liter bottle of pop is approximately 1/2 gallon. So, the average price of a gallon of pop is \$2.45.

About how much would 10 gallons of pop cost?

d.) _____ x _____ = _____

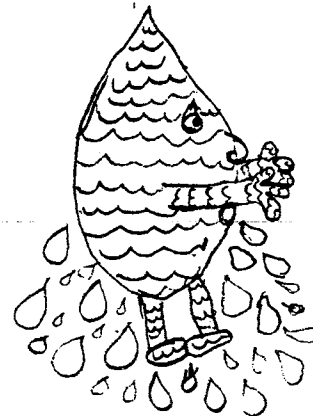
One gallon of milk costs about \$1.55.

About how much would 10 gallons of milk cost?

e.) _____ x _____ = _____

Since the average cost for water use is about \$1.30 per 1,000 gallons, the cost for use of 10 gallons is about \$0.01. Compare this price to the prices of the other two beverages.

Can you figure out what the price of 1,000 gallons of pop and 1,000 gallons of milk would cost?

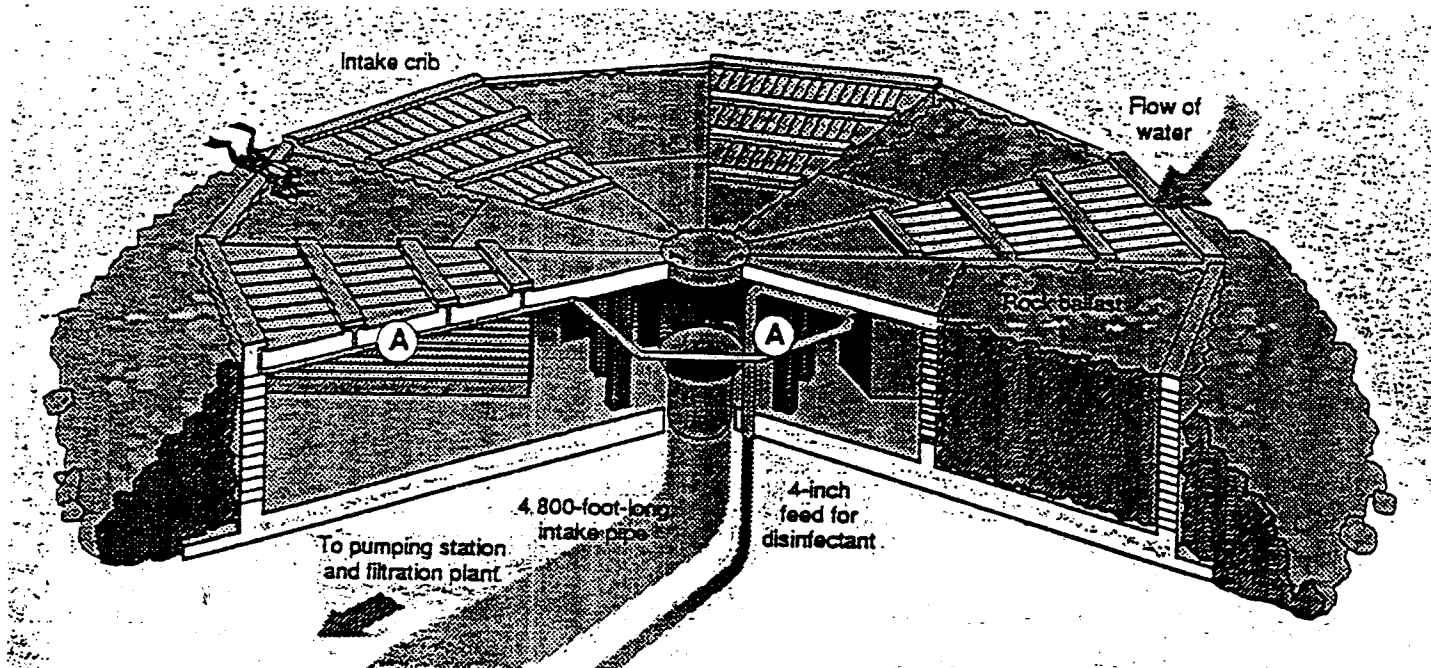


HOW CAN WE SAVE WATER?

Following these simple guidelines can make water conservation easy for everyone.

1. When brushing your teeth, turn the water off between rinsing.
2. Check all faucets, sprinklers and hoses for leaks.
3. Most bathtubs hold 50 gallons of water! When taking a bath, only fill your tub half way.
4. Do not dump hazardous wastes down the sink (paint thinner, oils, chemicals, insecticides, etc.) Dispose of them properly by taking them to a recycling agency or licensed contractor.
5. Do not run washer or dishwasher unless the machines are full.
6. Each time you flush the toilet, 5 gallons of water goes down the drain. Use the wastebasket, instead of the toilet for trash, such as kleenex.
7. Limit showers to 5 minutes in length.
8. Water is the main ingredient in all beverages. When you are thirsty, pour only what you need.
9. Keep a pitcher of water in the refrigerator or use ice instead of running the tap to cool water down.
10. When watering the grass or plants outside, be careful not to water the pavement.
11. Grow grass a little longer. Shorter grass causes more evaporation to take place.
12. Always, take only what you *need*!





City of Grand Rapids Lake Michigan Water Intake Crib

To assure customers an abundant supply of safe drinking water into the 21st century.

The water used by Grand Rapids area residents begins its journey far out into Lake Michigan at the new water intake crib. The massive structure represents a major engineering and construction achievement.

Location: In more than 40' of water, almost a mile offshore from the Lake Michigan Filtration Plant south of Grand Haven.

Size: 62' across and 11' tall.

Capacity: 111 million gallons a day - enough to fill more than 10,000 railroad tank cars.

Materials: Douglas fir - mostly 6 x 12" and 12 x 12" - enough to build 10 houses.

Weight: 216 tons - about the same as 15 fire trucks

Ballast: 540 tons of rock inside to hold the crib in place - another 1,350 tons around the outside to protect it.

Pipes: The intake pipe is 66" in diameter and buried 7' below the lake bottom. A 4" pipeline was

laid next to the intake pipe as a precaution against zebra mussels. The smaller line will carry chemicals that can be used safely to dislodge the mussels.

The new water intake crib was constructed on barges in the harbor at Frankfort, Michigan. When completed, it was floated off the barges and towed first to Grand Haven, then almost a mile offshore to the end of the intake pipe. Cranes and divers set the crib in place in August, 1990.

Water is drawn through the crib into the plant where it is treated and filtered before it is delivered to more than 240,000 customers in Grand Rapids and neighboring communities.

Consulting Engineers: Prein & Newhof

Grand Rapids

Contractor:

Luedtke Engineering
Company, Frankfort

Zebra mussels show up early at city's Big Lake water plant

By Kelley Root
The Grand Rapids Press

An unexpected onslaught of zebra mussels at Grand Rapids' Lake Michigan water-filtration plant is forcing city officials to attack the invading mollusks sooner than they planned.

Tiny mussels recently were discovered around intake pipes at the plant at M-45 and Lakeshore Drive in Ottawa County, City Engineer John Hornbach said Monday. The plant is undergoing expansion as part of the construction project for the city's second pipeline from Lake Michigan.

The immature mussels are not clogging pipes right now, but if left unchecked they could pose "severe restrictions" to the water-intake system, Hornbach said.

"They're very small, but the things grow and grow quite profusely," he said. "We're afraid that if we allow them to get growing they'll overtake us in a hurry. We need to nip

them in the bud."

Grand Rapids City Commissioners today were to approve costs for the engineering phase of a project to kill the mussels with a diluted chlorine solution. The entire chemical-control system, part of which already has been built, is expected to cost \$798,000, Hornbach said.

City officials had estimated the mussels would invade the plant sometime in the next few years, he said. To prepare for that, a chemical-feed pipe — which was not yet in use — was laid adjacent to the new Lake Michigan water-intake pipe when it was built in summer 1990.

"It was hoped that it would never happen, but we didn't think in Lake Michigan it would happen this fast," Hornbach said.

Besides the pipe laid in 1990, an older intake pipe built in the 1930s is still in use and needs protection from the mussels. The pro-

MUSSELS

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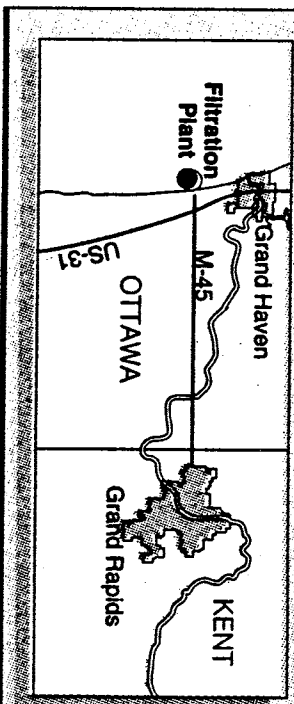
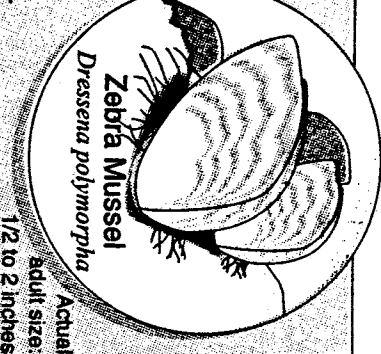
ject calls for a chemical-feed line to be inserted inside that pipe, Hornbach said.

The control system will release chlorine near the mouth of the intake pipes to kill the mussels. Currently, chlorination takes place at the plant, killing germs and making water drinkable.

Thomas Ecklund, assistant city manager for public works, said the city's approach to controlling the mussels is common and has been approved by the state Department of Natural Resources and the state Health Department.

Wyoming officials — who have a separate water pipeline — discovered zebra mussels on their intake pipes in October 1991, forcing them to begin construction of a similar chemical-control system. Holland, Grand Haven and other West Michigan communities also have found mussels on their pipes.

Zebra mussels, named for their distinctive light and dark stripes, have been detected at Grand Rapids' Lake Michigan filtration plant much sooner than expected. The tiny mollusks, which breed very quickly, were first discovered in American waters in 1988 and have since invaded all the Great Lakes. City officials estimate it will cost about \$800,000 to remove them.



PRESS GRAPHICED RIOLAS

The zebra mussel, which comes from Europe, was first discovered in American waters in 1988 in Lake St. Clair, east of Detroit. It is believed the mussels were brought in the ballasts of foreign freighters.

The pests have since spread to all five Great Lakes, the Erie Canal and most inland bodies of water in New York, and the Mississippi, Ohio and Illinois rivers. They threaten lake ecology by eating plankton essential to the food chain.

The fingernail-sized mollusk creates problems by clogging the water-intake pipes of boats, factories, power plants, drinking water facilities and irrigation systems. Female mussels can lay between 40,000 and one million eggs each year.